AZERBAIJAN REPUBLIC

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DEVELOPMENT OF NEW METHODS FOR İMPROVİNG THE QUALİTY OF VARİOUS REPAİR OPERATİONS CARRİED OUT İN OİL AND GAS EXTRACTİON WELLS

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ABSTRACT

of the dissertation work submitted for the degree of

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GENERAL CHARACTERISTICS OF THE WORK

Relevance of the topic: The State Oil Company of Azerbaijan, in addition to drilling new wells in order to increase and stabilize oil production, has set a goal for oil workers to develop new tools and methods that speed up the repair works for putting into operation the accident-inactive wells.

Because accidents in production wells occur at different depths, the condition of the accident termination, the condition of the accident zone, the limitation of internal dimensions of the casing, and other reasons, it is clearly determined that creating a universal, mature tool and equipment is not such a simple matter.

In poor-quality cementing, channels are created in the cement ring or on its contact with rock and protective pipes, through which water, oil, gas can flow from one layer to another. The presence of fluid flow is unacceptable regardless of the purpose of the well.

There are problems of developing effective methods of repair and isolation works, and their relevance is determined by the continuous wear and tear (aging) of the well fund.

Improvement of holding tools in repair-isolation work, creation of new progressive cementing technologies is one of the main directions of development of technique and technology of overhaul of wells.

The purpose of the work: development of new tools by improving the holding tools used in the elimination of complications and accidents in the operation and repair of oil and gas wells, and development of new technologies of cementing works in repair-isolation works and increasing the quality of repair operations by applying them.

The main issues of the research: The following issues were set and resolved in the thesis.

1. The main characteristics of the structural working elements of the existing structured pipe arresting tools used in the elimination of accidents, the nature and types of accidents occurring in operational wells, the reasons for pipeline arrest and the study of their release methods;

2. Development of appropriate technological holding tools, taking into account different well conditions, for the extraction of emergency pump-compressor pipes riveted with sand, corroded, deformed with a complex configuration, inner surface blocked from the well;
3. Researching the methods of holding and removing protective pipes from the well in the repair of small diameter elevator pipes and belt heads and developing new emergency internal pipe holders suitable for existing well conditions;
4. Development of a holding tool for removing the glass-plastic pump-compressor pipes with different standard sizes from the well;
5. Study of characteristics and power parameters of holding works in production wells;
6. Development of a special arrangement based on the study of the possibility of returning the well to operation in cases where it is impossible to remove the pump-compressor pipes riveted in cement from the well, in order to create the possibility of holding several constituent elements of the complex structure wellbore equipment.hazırlanması;
7. Study of the methods of releasing the tool caught in the production line during the repair of the accident well and the improvement of the technical capabilities of the hydraulic jack device used for this purpose;
8. Studying the improvement of the technical capabilities of mobile lifting devices used in drilling operations with side pipe cutting, the properties of various tamponage mixtures for the elimination of absorption zones, and the methods of transporting them to absorption zones;
9. Development and preparation of eccentric milling cutters and centering eccentric conductors in the repair of damaged wells;
10. Based on the comparative analysis of the operating parameters of the standard one-pillar and private two-pillar lock joint drill pipes used in the repair of the accident wells, determination of the torsional resistance ratios of the lock with respect to the pipe body;
11. Research of methods and methods used in non-pressure cementing and development of a new technology of creating a cement bridge in the repair of wells operated by the fountain method;

12. Development of an improved method of cementing under pressure in wells with strong fluid absorption.

Scientific innovations: the following scientific innovations were obtained as a result of the research works.

- 114 mm YB - DBT73 washer-holding tool was developed to remove the 73 mm NKB riveted with sand from the well in the 139.7 mm operational belt, and its optimal mode of operation was determined;
- a BO-114 pipe-overshot tool with a special handle was created for removing corroded elevator pipes from the well, and its structural and technological parameters were determined;
- a KK-type combined collocol was invented for the removal of deformed pipes with a complex configuration from the well, and its application was carried out for various purposes;
- two-fold DBT48 type-size (both moving folds) non-releasable internal pipe holder with increased washing ability was developed, its working principle was determined;
- a newly designed TVH 168-178 hydraulically released internal pipe holder was developed for the removal of emergency protective pipes in operational wells, the reliability of its release mechanism was demonstrated;
- in the repair of wells operated by the fountain method, new methods of creating a cement bridge without pressure and cementing under pressure in wells with strong liquid absorption, well inspection methodology were developed during the preparatory period of the process of cementing under pressure in wells with strong liquid absorption;
- in the repair of damaged wells, after passing through the place with a small (narrowed) inner diameter in the upper part of the production line, an eccentric milling cutter for milling the bottom of the damaged end located in the wider lower part with a milling cutter of the required diameter, which is part of the substructure of the drill pipe, which makes it possible to create the possibility of milling and holding the centering eccentric pipe conductor is developed;
- the characteristics of holding works in operational wells and the determination of power parameters of holding work with holding tools

with a wedge-wedge gripping mechanism were methodically worked out and their use in production was ensured.

Protected issues (provisions):

- Development of BO-114 pipe-overshot, KK-type combined and 114-mm box-cutters with guide-cut guide, 114-mm YB - DBT73 washer-holder technological emergency tools;
- structural layout of internal pipe holder emergency tools DBT48 type-size mechanically effective non-releasing and TVH 168-178 hydraulically effective release with improved washing ability;
- eccentric wellbore cutter and pipe cutter;
- the methodology of holding works in exploitation wells and the calculation of power parameters;
- cutting-type guiding special mold design;
- application of hydraulic power rotary in drilling with side barrel cutting through mobile hoists;
- improvement of the working principle of the used hydraulic jack device and the method of freeing the blocked pipeline;
- the method of creating a cement bridge with a special technology using a non-return valve;
- improved method of cementing under pressure;
- treatment of tamponade solutions with special composition to eliminate fluid absorption.

Practical significance of work and application of results. The results of the dissertation make it possible to solve the following practical issues:

1. Washing of the back of pump-compressor pipes riveted with sand in the 139.7 mm operational belt and removal from the well by performing one operation (flight) with the 114 mm YB - DBT73 washing-holding tool;
2. Elevator pipes, submersible pumps, their components, whose outer diameters have decreased due to corrosion, cables and cable parts that have been riveted behind the submersible pump, as well as twisted pipes that have flown into the well, are brought to the ground with a special handle BO-114 pipe-overshot tool;
3. Excluding the operations of milling the damaged ends of deformed pipes with complex configuration with FZ, FK, FM type milling

cutters, these ends are collected towards the center and made suitable for holding, straightener-holder with a wide holding range of damaged pipes in different well conditions, as well as those whose inner surface is cemented. Extraction from the well in one operation with a KK-type combined box cutter;

4. Reliable and perfect holding of damaged 48 mm pump-compressor pipes with DBT48 type-size non-releasing internal pipe holder with increased ability to wash both sides;

5. After lifting the protective pipeline that slipped down as a result of an accident in production wells, the reliability of the release mechanism has been increased by simplifying the construction, with the TVH 168-178 hydraulically effective release internal pipe holder, its easy release;

6. Removal of components of drilling equipment and emergency tools, as well as glass-plastic pump-compressor pipeline that has flown into the well, with a "floating lock" non-releasable internal pipe arrester with a cut-off bit and a cut-off collar adapted to the captured object;

7. In cases where it is impossible to remove the NKB riveted in cement and the equipment inside the well from the well due to technical reasons during the repair process, the well is returned to operation by installing a cutting-type guiding special screw arrangement installed in the accident area, by digging out the cement stone inside the pipe, or by washing the sand plug;

8. In the repair of the accident well, the drill pipe riveted with metal objects in the operational pipeline is released in stages by making changes in the working procedure and installation of the hydraulic jack device used for this purpose;

9. Creating a high-quality cement bridge in the well at the planned interval with the use of a non-return valve in the repair of wells operated by the Fontan method;

10. In wells with strong liquid absorption, creating a cement bridge by excluding pipes from being caught in cement and ensuring the safety of the well during cementing under pressure, carried out by an improved method;

11. It is important to improve the quality of catch works in operational wells

Methodical guidance developed for the determination of characteristics and strength parameters in the release of trapped pipes ensuring its application;

12. In the repair of damaged wells, the required diameter milling of the damaged end, which is located in a wider part below the small (narrowed) inner diameter in the upper part of the production line, with a small-diameter eccentric well-bottom milling cutter, and the application of an eccentric conductor in the bottom assembly of the drill pipe, milling with relatively small diameter milling cutters and centering design creation of an opportunity to hold when it is impossible to use;

13. Making it possible to prevent or significantly reduce repeated cementings by applying specially formulated tamponade solutions used in pressure cementing of wells with strong liquid absorption.

The application of all the methods developed above and emergency tools in production is approved by relevant acts.

Approval of work. The results of the thesis were presented at the following conferences and seminars: Материалы международного семинара «Рассохинские чтения», «Ухтинский государственный технический университет», Ухта; Материалы VI международной научно-практического конференции «Булатовские чтения», Краснодар, 2022; сборник трудов III международной научно-практического конференции «Инновационные технологии в нефтегазовой отрасли», «Северо-Кавказский федеральный университет», Ставрополь, 2022.

The structure and scope of the work: The dissertation consists of an introduction, 5 chapters, a conclusion, appendices and a list of used literature. The total volume of the work consists of 150 pages, excluding pictures (52), tables (16), bibliography (57) and appendices.

Publication of the work: The results of the thesis are presented in 29 scientific works, including 9 articles (4 of them in the Russian Federation), 9 inventions, 6 textbooks, methodical materials - the Collection of Special Instructions for Well Repair, 1 Guideline and 3 conference materials (3- also in the RF) has been announced.

New technological tools and cementing methods were approved by the State Committee on Patents of AR, by Intellectual Property

Agency with 8 Inventions No.I 2013 0050, I 2014 0019, I 2014 0020, I 2014 0077, F 2015 0006, F 2020 0029, İ 2020 0050, F 2022 0010 and by "Eurasian Patent Organization" with 1 Invention No. 038472.

CONTENTS OF THE WORK

In the introduction, the relevance of the thesis is justified, the purpose of the main issues is formulated, and its practical importance is indicated.

In the first chapter, a broad overview of existing arresting tools (pipe arresters) used in the overhaul of oil and gas wells, their classification, working principle, arresting works, analysis of the main characteristics of the working details of their constructions, and the conclusions drawn from the analysis are given.

In the second chapter, the characteristics and types of accidents in operational wells, the classification of accidents, the reasons for the occurrence of accidents during the period of production and overhaul and their prevention methods are given.

The reasons why pipes are caught (riveted) in the well during operation, repair, and drilling of wells have been analyzed. The methods of determining the location of the rivet of the pipeline, the determination of its upper limit, the methods and methods of releasing the non-riveted part of the pipeline are explained.

The causes of the pump compressor pipe pipeline being blocked by sand and the operations for their release were investigated. The methods of removing 73 mm sand-encrusted pipes in the 139.7 mm production line and the performance characteristics and difficulties of the tools used for this purpose were analyzed.

The methods of removing corroded lift pipes from the well and the operational characteristics of the tools used for their implementation and the difficulties that arise are analyzed.

The reasons for the deformation of the pipe ends in the accident wells were investigated, the methods of removing these pipes from the well and the major problems arising in their removal were noted.

In the course of major repairs, pump compressor pipe riveted in cement or in cases where it is not possible to remove the equipment inside the well, the ways of returning the well to operation have been

investigated with pump compressor pipe in the case of closing the lowered diverter-muff arrangement at the end of the emergency pipeline, the impossibility of drilling cement and washing sand inside the emergency pipeline as a result of the very high circulation pressure and the fact that the pipeline consists entirely of small-diameter pipes was analyzed.

During the well repair, the causes of the internal surfaces of the damaged pipes were investigated, and the possibilities of application of the tools used to remove the 73 mm damaged elevator pipes from the well with a 139.7 mm operational belt were investigated, and the necessity of milling was analyzed as the only solution.

During the operation of the well, the construction and operation characteristics of the holding tools used for removing pipes of the specified size for washing from inside the II row consisting of 48 mm pump compressor pipe flown into the well or the riveted I row were investigated. The difficulties in inserting the single-pass DBT48-80 pipe holder into the pipe have been analyzed.

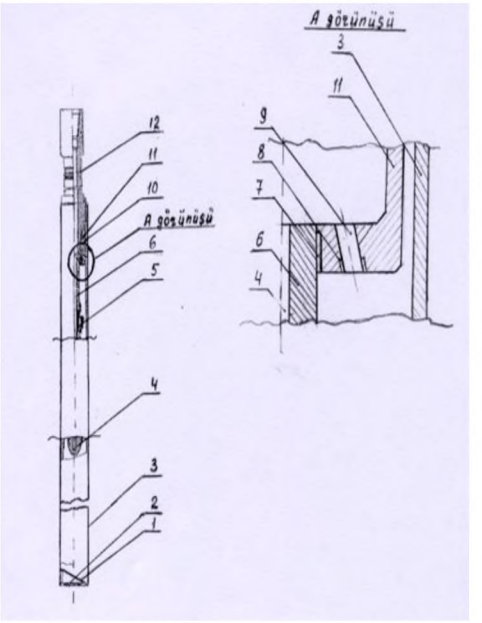
Power parameters in holding works in accident wells and in riveting of various tools were analyzed - compressive and tensile force load along the optimal axis for holding with piston holders, permissible load in loosening, determination of the number of safe cycles in rotation of drill pipes.

The technical capabilities of the mobile hoists used in side barrel drilling were investigated and the importance of increasing some of their technical parameters to open the window and speed up the drilling was reported.

The installation and operation characteristics of the hydraulic jack used in the removal of riveted drill pipes in the well were analyzed. It is shown that working according to the installation scheme in its instruction manual is not enough to free the pipes from the rivet.. The problems arising in the removal of the downhole equipment with an emergency complex structure, which ensures the prevention of the open fountain warning, have been investigated. Taking into account the situation of all their elements in mutual contact with each other, the problem of adapting the existing holding tools to well conditions was analyzed.

In removing the damaged glass-plastic pipes from the well with existing holding tools, it was investigated whether the damaged belt could not be removed due to deformation of the pipe without loading.
During the repair of the casing head of the accident wells, for the purpose of restoring the previous condition of the down-sliding production pipeline, the existing freed internal pipe holders were investigated in order to tighten it. The reliability of their release mechanism was analyzed and it was noted that there is a need to increase the reliability.
The methods for freeing the tool from the rivet after a certain distance raised by the fall of the foreign object falling into the well were analyzed.
The complications of working with relatively small diameter milling tools and holding tools when the diameter of the belt is greater than the inner diameter of the upper part of that type-size belt or there are narrowing zones in the upper zone of the belt at the end of the accident were analyzed.
The results of the methods used in the elimination of accidents that occurred in operational wells and the setting of research questions, i.e., the issues posed by the dissertation - which are important to be worked out, are issued in the work.
Improving the quality of the work performed by applying new techniques and technologies in the repair of wells creates the basis for the formation of the thesis as the goal.
In the third chapter, the reasons for not obtaining a cement bridge due to complications arising in the technology of creating a cement bridge by the balance method in wells operated by the fountain method were investigated.
Hazards expected in wells with strong fluid absorption were investigated. Mineral-based tamponade materials applied to isolate intensive absorption zones and the application of fillers to reduce absorption were investigated.
Cementing methods in well repair-isolation works the results and setting of the research questions, i.e., the issues posed by the dissertation - which are important to be worked out, are given.

In the fourth chapter, the research works related to the development of new accident tools - gripper, milling tools and methods and the development of improved new cementing methods for use in the elimination of accidents in oil and gas wells are reflected.
Here is the result of the thesis:
1) 114 mm YB-DBT73 washer-holding tool (fig.1) capable of washing and removing 1 flight of 73 mm pump compressor pipe with 89 mm sand-clogged coupling in 139.7 mm operational belt (fig. 1);
2) The BO-114 pipe overshot, which allows the removal of the 73 mm (48 mm) pump compressor pipe, the centrifugal electric submersible pump, its components and the cable parts collected in the wellbore, which were poured and riveted behind the device, and which are in a relatively fragile state, the external diameter of which has been eaten away due to corrosion and flown into the well (fig.2);
3) Classification of complex configuration deformed accident endings (Fig. 3); KK-type combined box-cutter, whose end has deformed pipes with a complex configuration, can be removed from the well in 1 flight and can be applied to a wide holding range and in various emergency well conditions (Fig. 4);
4) In cases where it is not possible to remove riveted pump compressor pipe or downhole equipment during cementing, drilling of cement with small-diameter washing pipes from inside the accident belt and allowing sand to be washed at a much lower pressure - design of a cutting-type directional special funnel (Fig. 5) and its installation in the accident area (fig. 6);
5) 114 mm K100x78 box cutter (fig. 7) to grab it and remove it from the well, excluding the mandatory operation of milling the coupling of the 73 mm NKB, whose inner surface is held eccentrically in the 139.7 mm operational belt, with appropriate milling cutters;
6) DBT48 non-releasing internal pipe holder with two moving pistons with structural changes to increase the holding capabilities of the 48 mm NKB holder (fig. 8);



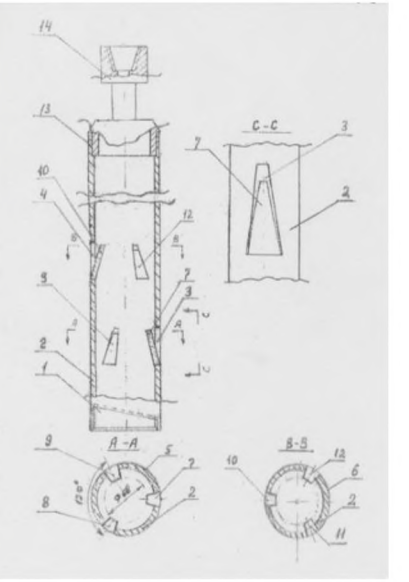
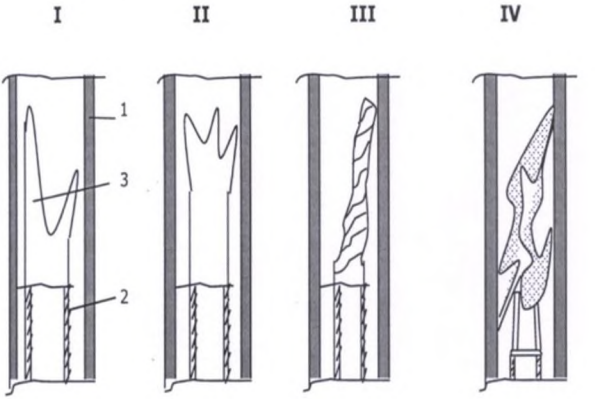


Fig.1.114mmYB-DBT73 washing-holding instrument

Fig.2. BO-114 holding instrument.



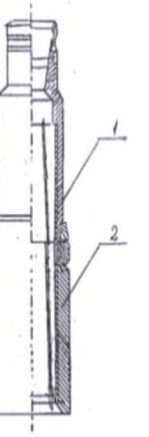
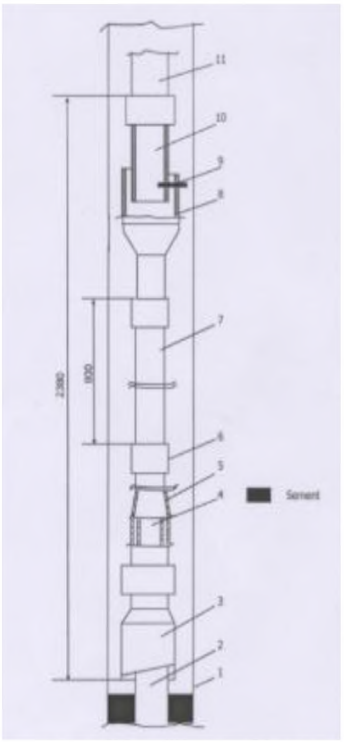


Fig. 3. Deformed accident endings:
1 – operational pipeline; 2 – damaged pipe;
3 - accidental ending (ellipse, "petal" tongues, as opened, twisted as a spiral, etc.)

Fig. 4.Combined box-cutter (KK



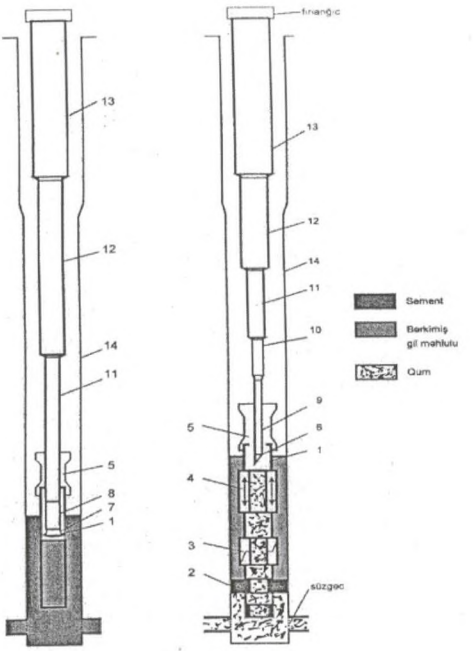
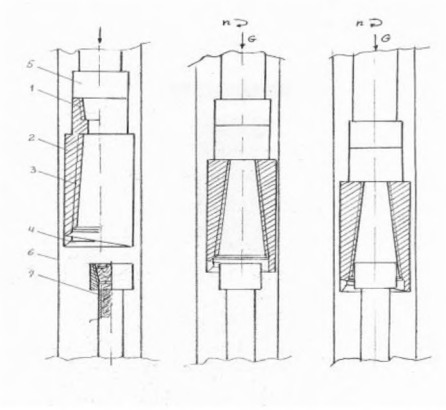


Fig.5.Cutting-type guide-fleece design *Fig.6. Schematic illustration of a cutting-type guide-wire arrangement application.*



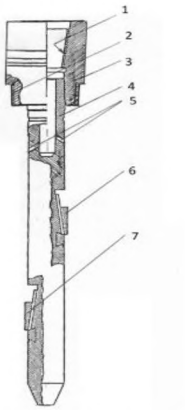


Fig.7. Working order with box-cutter. *Fig.8. Double-sided internal pipe holder.*

7) The characteristics of holding works and power parameters during holding were analyzed, the methodology of conducting holding works in production wells was developed, and a table was developed for determining the number of safe cycles allowed for rotation in the opening operation with welded drill pipes by calculating the power parameters.

Table.

Nominal diameter, inch	Wall width, mm	Depending on the weight of the drill string, for 1000 m of class I pipes, in t								
		0,1	10	20	30	40	50	60	70	80
60,3 (2 3/8")	4,83 7,11	18 3/4 18 3/4	18 1/4 18 1/2	16 3/4 17 3/4	13 1/2 16 1/4	14 1/4				
73,0 (2 7/8")	7,82 9,19	15 1/2 15 1/2	15 1/4 15 1/2	14 1/2 15 1/4	13 1/2 14 3/4	11 1/2 14	8 3/4 13 1/4	12	10 1/2	8 1/2
88,9 (3 1/2")	6,45 9,35 11,4	12 3/4 12 3/4 12 3/4	12 3/4 12 3/4 12 1/2	12 1/4 12 1/2 12 1/2	12 12 1/4 12 1/2	11 1/4 12 12 1/4	10 1/4 11 1/2 12	9 1/4 11 11 1/2	7 1/2 10 1/4 11	4 3/4 9 1/2 10 1/2

8) It was investigated that providing the required rotation frequency of the milling cutters for the side barrel drilling is beyond the technical capabilities of the used mobile hoists. For this purpose, the S-120 hydraulic "power rotary" device (fig. 9) has the working parameters necessary for milling and, first of all, the frequency of rotation, and the prospects of its application were considered.

9) Installation of the QDZ-300 jack device for removing the riveted pipes from the well, according to the Manual, which describes the operation procedure, taking into account that the height of the piston in the release of the riveted pipeline is not sufficient to cancel the rivet, a new hydraulic jack device is installed at the wellhead, which allows to significantly increase the possibility of releasing the pipeline. method of installation and working with it (fig. 10).

10) Complications in the repair of accident wells - when the retaining or washing tool remains in the well or in the case of breaks on the equipment inside the well, in the close proximity to them, certain problems arise in the selection of the tool for their removal from the well. Also, in the partial removal of complex well equipment, it is not

possible to hold it with standard universal drills due to the possibility that one of the interacting elements will interfere with the other.
These holding tools are adapted to the well conditions - the holding range is reduced, i.e. cut to the required size, as cutting taps and collars are applied in special cases in the appropriate well conditions.

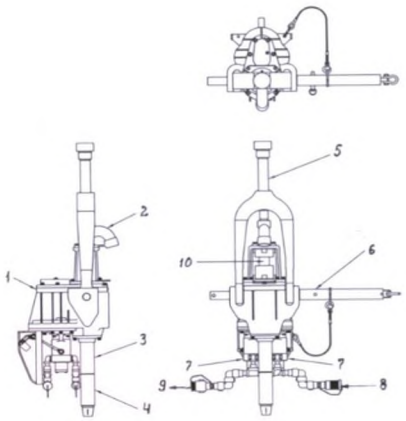


Fig.9. S-120 Power Swivel hydraulic "power swivel"

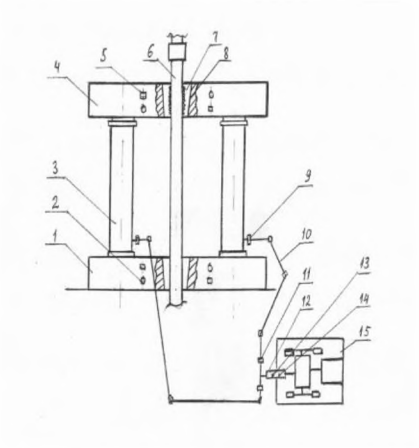


Fig.10. New installation scheme of the of the hydraulic jack assembly

11) Despite holding the damaged glass-plastic pipes from the well by the body with a standard internal pipe holder, it is not possible to remove the damaged belt by releasing the tool from the rivet due to the deformation of the pipe without loading. A floating lock holding tool, which makes it possible to carry out the holding work and remove it from the well, by riveting it from within the coupling joint located below the broken place in the pipe body (fig. 11);

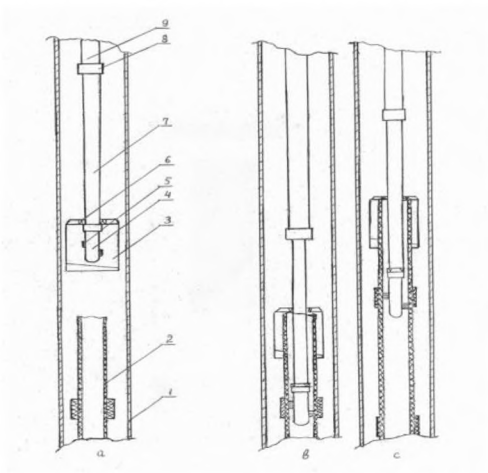


Fig.11. Floating lock holder tool.

12) When the 168.3 mm or 177.8 mm operating casing slides down together with the bushings in the casing head repair of the accident well, it was impossible to apply the existing mechanical and hydraulically effective release holding tools to restore the previous condition of the casing for many reasons. The problem has been solved - the reliability of the release mechanism has been increased by simplifying the construction (fig.12);

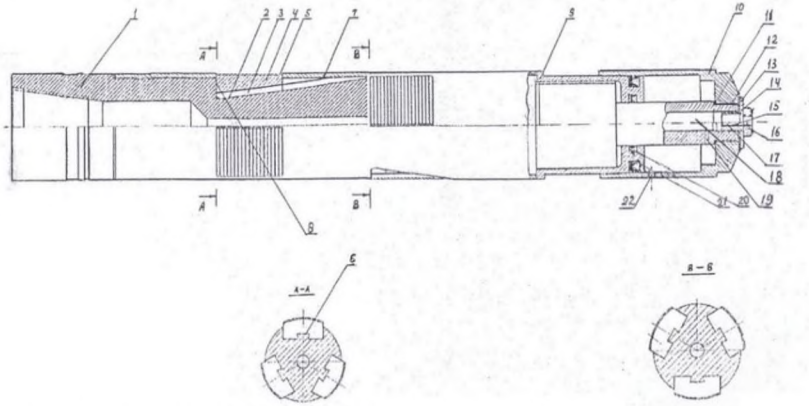


Fig.12. TVH 168-178 hydraulically released internal pipe holder.

13) Complete riveting of the tool (milling tools, holding tools) with pipe fractures of metallic origin is well known from the experience of repair of accident wells, with limited up and down movement after lifting it from the working zone to a certain extent due to various reasons.

In such cases, a new method of freeing the lowered tool with riveted drill pipes has been developed, the essence of which is as follows: when opening the pipe, the traction force is applied much less than the weight of the pipeline, and due to the presence of a significant load on the riveted tool during opening, a large force directed downwards to the tool as a result of the push-resonance generated in the opening of the pipe impact force (which can be compared to the downward impact work of flats) is given. As a result of the impact, the tool is freed from the rivet with the metal object and rolls down to the bottom of the well together with the drill pipes. After that, by lowering

the pipeline and closing it from the opened place, the drilling pipeline is raised together with the tool.

14) The well construction consists of protective pipes with different wall thicknesses, in some cases the upper part is thicker and the lower part has a relatively thin wall thickness. Also, during the repair of the well, the internal diameter of some of the repaired intervals is reduced in order to restore the hermeticity of the operational pipeline. An eccentric flat-bottomed wellbore cutter (fig. 13) and the procedure for working with it (fig. 14) that enables milling of the emergency end located in the wider lower part with a wellbore cutter of the required diameter after passing through a place with a small (narrowed) internal diameter at the top of the production line (fig. 13);

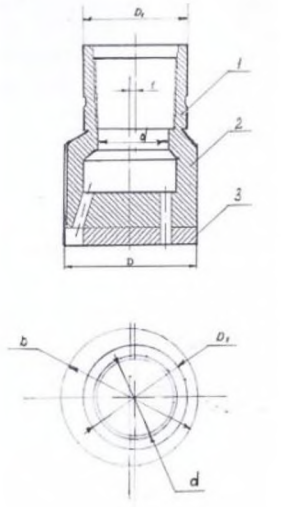


Fig.13. Eccentric flat bottom hole cutter.

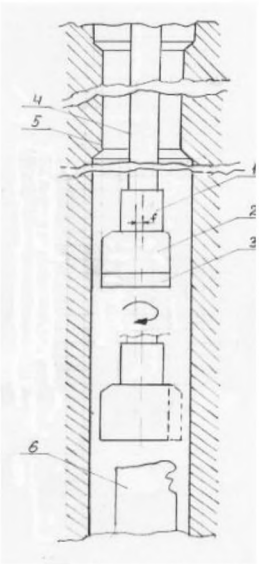


Fig.14. The procedure for working with an eccentric flat-bottomed well-bottom milling machine.

15) After passing through the narrowed area above in the production line, the emergency end located in the wider lower part is milled with milling cutters of the required diameter, and in order to create the possibility of capturing the emergency pipe by centering the holding tools in the production line, the eccentric pipe conductor applied in the substructure of the drilling line (Fig.15) and with it the order of operation (Fig.16);

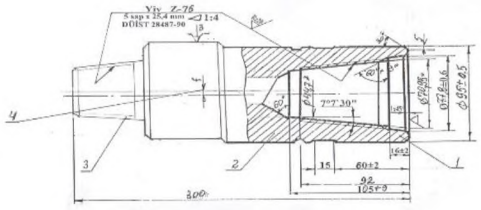
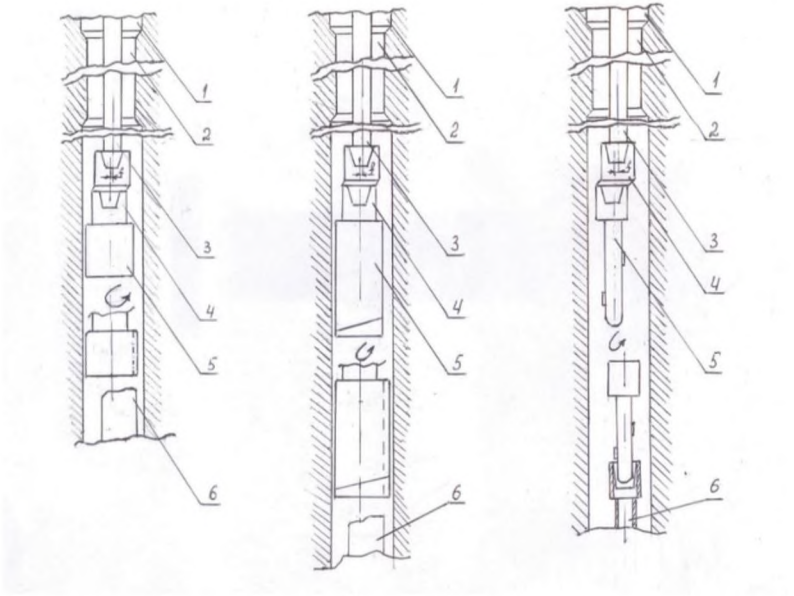


Fig. 15. Eccentric conductor with drill lock groove.



a b c

Fig. 16. Methodology of operation of downhole cutter (a), retaining collet (b) and internal pipe holder (c) with the application of an eccentric conductor with a drill lock groove.

16) Fontan Since it is impossible to have an ideal homogeneous specific gravity solution along the entire length of the wells in Fontan wells, it is impossible to have a counter valve in the cementing pipes and by changing the composition of the pressure liquid - with a special technology, following the condition that the pressure caused by the liquid column inside the pipe is less than the pressure caused by the liquid column behind the pipe. A new method of creating a cement bridge was developed. The calculation method of creating a cement bridge using a new method is shown in Figure 17;

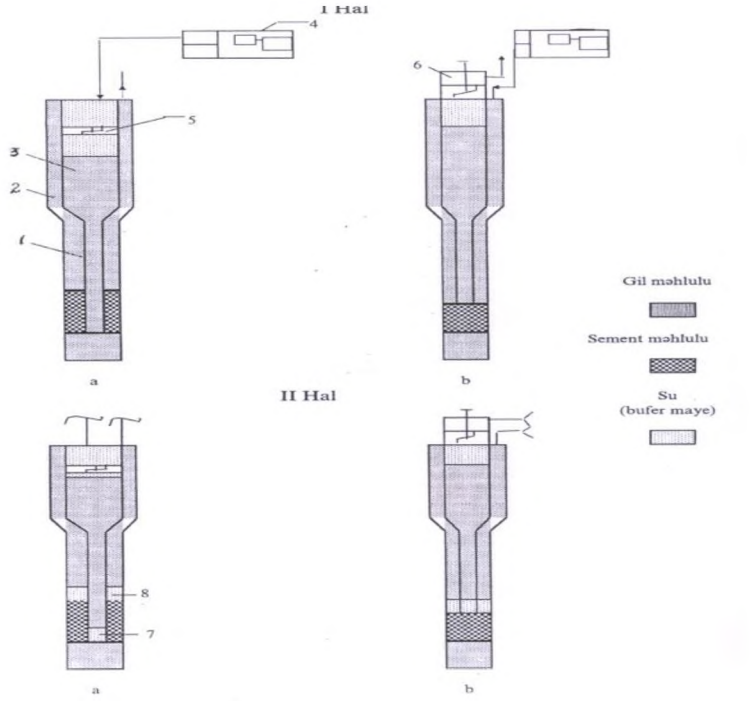
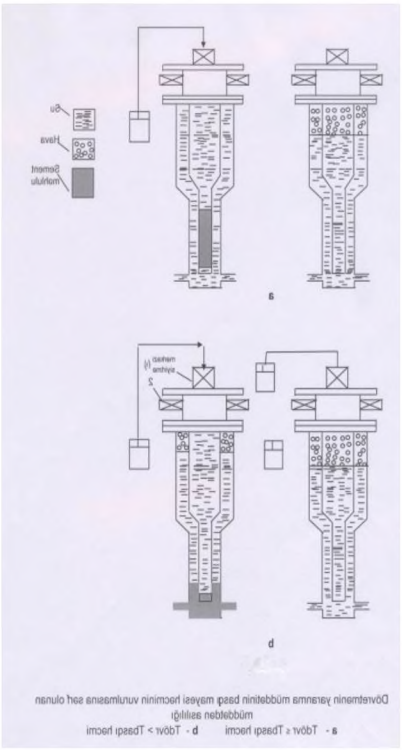


Fig.17. Creating non-pressure cement bridges in Fontain wells new method

17) During the preparatory period of the cementing process under pressure, the method of determining the degree of absorption in the well (based on Fig. 18) was developed.

The main danger that may arise - the situation that will cause pipes to be stuck in cement - has been investigated. An improved new method, which takes into account measures against the expected danger, has been developed and the procedure for carrying out the method is shown (fig. 19);

18) Different properties and application possibilities of mineral-based tamponade materials were analyzed in pressure cementing of wells with strong liquid absorption. The application of gypsum-cement and clay-cement mixed solutions was investigated in the isolation of absorption zones. Tamponing solutions with special composition - sequence of using these two solutions separately in



isolation of gypsum-cement and clay-cement mixed tamponing solutions.

Fig.18. Cementing under pressure.

18) The different characteristics and application possibilities of mineral-based tamponade materials were analyzed in pressure cementing of wells with strong liquid absorption. The application of gypsum-cement and clay-cement mixed solutions was investigated in the isolation of absorption zones. In the process of isolation of tamponade solutions with special composition - gypsum-cement and clay-cement mixed tamponade solutions, the sequence of using these two solutions separately was worked out.

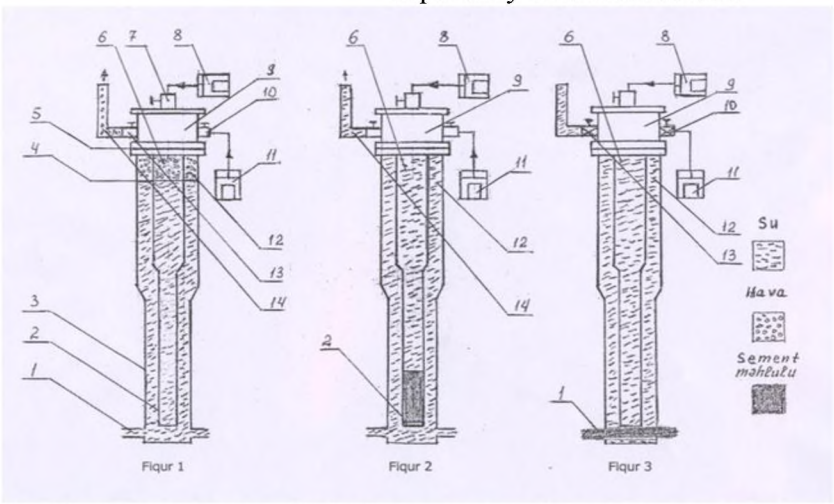


Fig.19. An improved method of cementing under pressure in wells with strong fluid absorption.

19) Accelerators of ignition in the isolation of absorption zones were studied, the properties of the plaster-cement mixed tamponade solution were studied and the methods of their delivery to the absorption zone were analyzed.

In order to determine the parameters of the tamponade mixture and to select the cementing technology of the absorption zones depending on the results, the research of the properties of the tamponade solutions with gypsum-cement mixture was carried out in the laboratory of Oil and Gas Extraction Department in the name of H.Z. Taghiyev, and the following issues were its subject:

1. Determination of the main technological parameters (density, fluidity, setting times) of gypsum-cement mixtures prepared in different proportions of cement and gypsum components depending on the temperature environment;

2. Determination of the influence of gravel (shell - small "cockle-shell") fillers on the properties of the investigated tamponade mixtures;

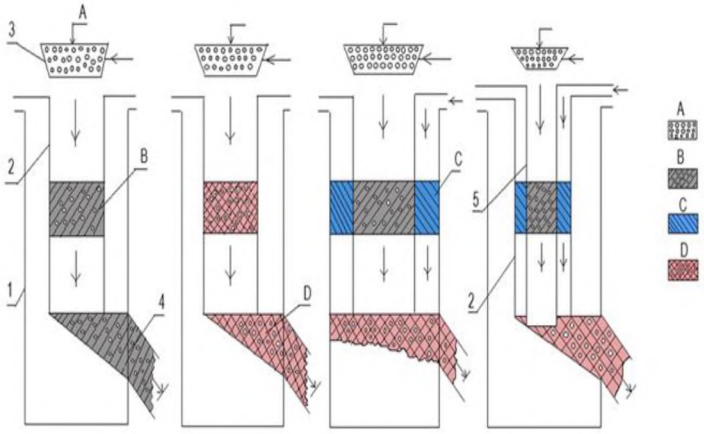
3. Selection of the tamponage mixture recipe based on the research materials and the method of delivery of the tamponage mixture to the absorption zone depending on the absorption intensity (Fig. 20).

Absorption intensity categories have been determined based on the experience of drilling operations with side-barrel cutting in the Oil and Gas Extraction Department in the name of H.Z. Taghiyev of Azneft PU.

A table has been developed that summarizes the results of measuring the main parameters of the gypsum-cement tamponade mixture.

20) A comparative analysis of API standard single-leg and private double-leg lock joint drill pipes was carried out.

In connection with the operation of the drilling tool under severe conditions in modern drilling conditions, strict requirements are imposed on the structure of the drilling belt (composition), its strength and geometric characteristics, one of them is the optimization of the geometric parameters of the drilling locks.



Scheme 1. Scheme 2. Scheme 3. Scheme 4.
Fig.20. Mthods of delivery of the tamponade mixture to the absorption zone.

Hilong, NOV Grant Prideco, TMK company's comparison of the torsional resistance ratio of the lock of the drill pipes with respect to the pipe body, the result was drawn and presented in the form of a table.

In the fifth chapter, the prospects of industrial application of the results obtained from the application of the developed new technical and technological methods in the repair of operational wells are given. Determining the field of application of developed emergency tools, layout and cementing methods, that is, choosing the appropriate tool and method for the relevant well conditions in the well being repaired, is a very important issue.

1. The 114mm YB-DBT73 washer-holding tool designed for the removal of 73mm NKB in the 139.7mm production line was successfully applied in the accident wells of the "28 May", "Neft Daşlari" OGED, if necessary, also it is recommended to be applied in other OGEDs.

2. BO-114 holding tool designed to hold and remove from the well the 73 mm (48 mm) NKB belt, MEDN and its constituent parts and cable parts, which have been eaten into the well as a result of corrosion and are in a relatively brittle state are applied successfully in

OGED named after May 28, Siyazanneft and H. Z.Taghiyev, in necessary cases it is recommended to be applied in all "Azneft" PU.

3. In order to carry out the removal of deformed pipes with a complex configuration from the well in one operation, the developed KK type combined box-cutter has been successfully applied 100 times in all emergency wells of all structural organizations of "Azneft" PU and is recommended to be applied when necessary.

4. Pipes riveted in cement can be removed from the well

in the absence of such cases, for the purpose of excavating the cement stone inside the pipe or washing the sand plug, the design of the cut-off type guiding special funnel installed in the accident area was applied in the wells No. 264, 107 of the OGED 28 May. For this reason, it is recommended to apply this arrangement in cases where it is not considered appropriate to continue the repair works.

5. 114 mm K100x78 box-cutter with 114 mm K100x78 bell, which was processed without milling the damaged 73 mm NKB, whose inner surface was trapped in the 139.7 mm production line, this tool has been successfully used many times in the removal of pipes in the damaged well No.477 of GAII and wide under appropriate well conditions recommended for application.

6. In order to exclude possible complications in the repair of the well, the two-layer DBT 48-92 internal pipe arrester, which performs reliable holding work, was successfully applied in the wells of "Neft Dashlari" OGED, and it is recommended to apply it when necessary in the repair of other wells of "Azneft" PU.

7. When performing complex work, the power parameters, especially the number of safe cycles, are set correctly according to the table in the guideline document - instructions, so the breakage of pipes is excluded, and it is recommended to use it when complex operations are performed.

8. In case of side barrel drilling with mobile hoists, it is recommended to use the S-120 hydraulic power rotor for milling with the required rotation frequency in the opening of the window with milling cutters.

9. In the removal of the riveted drilling tool in the well, the improved working principle of the hydraulic jack device by changing the

installation scheme was successfully applied in the removal of the riveted drill pipes at the OGED "28 May", "Siyazanneft", "Bibiheybatneft", OGED named after A.J. Amirov and H.Z. Taghiyev and it is recommended to apply this improved method in the future.

10. Creation of the possibility of holding at least two elements of the complex-structured downhole equipment in the accident wells, as well as the holding range adapted to the well conditions in the holding of the coupling of the 73 mm PCP with a VAM thread connection, the cut drills with a reduced range and the holding range adapted to the well conditions in the removal of the retainer-washer tool left in the well reduced cross-sectional collars were successfully applied in "May 28" OGED. In appropriate well conditions, it is recommended to use a cut-off bit and collocol with a reduced holding range.

11. The developed internal pipe holder with "floating" lock, which ensures safe holding of damaged glass-plastic pipes, was successfully applied in the well No. 3231 of "Bibiheybatneft" OGED, and it was recommended to use such pipes for holding and removing them from the well.

12. In order to restore the previous condition of the 168 and 178 mm production line that slipped down during the repair of the emergency well due to the belt head, it was worked due to its tension - the reliability of the release mechanism was increased. It has been successfully applied in the repair of wells in the deep seabed, and it is recommended to contain them in accidents caused by these protective pipes.

13. The method used for riveting the tool in the belt after lifting it from the working area by pulling it from the working zone of the well tool riveted with pipe fragments of metallic origin or with a foreign object that fell into the well was successfully applied in the repair of the accident wells of the "May 28" OGED, and this type of riveting of the drill pipe the application of the method is recommended.

14. When the diameter of the belt at the end of the accident is greater than the inner diameter of its upper part, when milling a relatively small diameter eccentric flat-bottom well with a milling cutter - the large diameter required depending on the eccentricity distance during rotation is covered by the milling cutter. In such well conditions, it is

recommended to use eccentric flat-bottomed well bottom milling cutters in the milling of the accident end.

15. In the event that the diameter of the belt is greater than the internal diameter of its upper part at the end of the accident, it is recommended to hold the pipe without using a centralizing arrangement with holding tools, as well as to apply an eccentric pipe conductor in the substructure of the drill string when milling with a relatively small diameter wellbore and ring cutters.

16. In the widely used balance method for creating a cement bridge, it is known from the repair experience that the cement bridge does not form in the intended interval due to the non-uniformity of the drilling solution along the entire wellbore.

The creation of a cement bridge with the use of a reverse valve in the cementing pipeline, as well as with a developed special technology based on changing the composition and content of the pressure fluid, was applied in the wells of "May 28" OGED and Gas Storage Operation Department, and this new method was recommended to be applied to create a cement bridge in the fountain wells of "Azneft" PU.

17. During the preparation period of the cementing process, after determining the absorption capacity in the well according to the developed methodology, the developed new method that prevents the danger of seizing the cementing pipes in pressure cementing in wells with intensive liquid absorption capacity was applied in "May 28" OGED. In other structural organizations, it was recommended to apply this new method in wells with strong fluid absorption.

18. The expediency of using gypsum-cement solution for closing the absorbing areas of the wellbore with large cracks, as well as the fact that the clay-cement mixture has the ability to quickly set with a slight penetration into cracks and pores, necessitates the use of such mixed tamponade solutions in the isolation of absorption zones by cementing under pressure.

Depending on the intensity of absorption, the prospect of applying the first mortar gypsum-cement or clay-cement mortar, followed by the injection of the second batch mortar without admixture, is highlighted. The sequence of use of these two solutions in the isolation work was worked out and their application was recommended.

19. Based on the materials of experimental research conducted in the laboratory of OGED named after H.Z.Taghiyev, the methods of delivery of the tamponade mixture to the absorption zone were developed, depending on the intensity of absorption, by selecting the recipe of plaster-cement mixture tamponade solutions.
20. API standard of double-core drill pipes of private companies a comparative analysis with supported drill pipes was carried out. A table showing the comparison of the torsion resistance ratios of the lock with respect to the pipe body with the same geometric dimensions of the lock has been developed.
The comparative analysis of these drill pipes has recommended the use of two-pillar drill pipes in the repair of wells with complicated accidents and side barrel drilling in the 140 mm production line.

CONCLUSION

1. On the basis of the analysis of the conducted research works, the optimal parameters of the construction of pipe clamps were determined, and the existing pipe clamp tools were classified according to the characteristics of the riveting place. Also, the perspective of installing a hydraulic power rotary device was determined to enable the milling and rock-breaking tools to work in accordance with their technical characteristics in the technological operations carried out in the drilling works by cutting the side barrel with mobile lifting devices.
2. Methods of creating an unpressurized cement bridge in wells using drilling fluid during repair and isolation works and methods of cementing wells under pressure, methods of checking the well during the preparatory period of the cementing process under pressure in wells with strong liquid absorption, as well as researching the properties of tamponade solutions with special composition for isolating absorption zones and the technology of transporting them to the corresponding zones depending on the absorption intensity has been developed.
3. Mechanically effective non-releasing suitable for the removal of small-diameter damaged steel and glass-plastic pump-compressor pipes from the well, which are in different positions in the well: the

end is deformed or corroded with a complex configuration, the back is clogged with sand, as well as for the capture and subsequent release of protective pipes. and hydraulically released internal pipe holders were developed and put into operation.
The methodical guidance on the determination of the characteristics and power parameters of the holding works in the production wells was developed and its application to the production was provided.
4. In order to remove the accident complex structure drilling equipment, its component elements, VAM threaded joint pipe coupling and emergency washer-holding tools from the well, cutting-holding taps and collars adapted to the captured object are prepared, and if it is impossible to remove these equipment from the well, they are installed on the accident end and the tool a special design of a cut-off type guide, which makes it possible to dig the remaining cement or wash the sand by directing it into the pipeline, has been developed.
5. An eccentric flat-bottomed wellbore cutter used in drilling operations of the emergency end in the wells with narrowing zones in the production line and a centering eccentric conductor included in the substructure of the drill string, which makes it possible to mill the emergency pipe end with the wellbore, annular cutters and secure holding with the holding tools, have been developed.
6. In the repair of the accident well, the method of releasing the tool riveted with metal objects in the production line, the method of installing and working improved the hydraulic jack device, and the methodology that ensures the removal of the drill pipe from the well in stages was developed.

APPENDIXES

Appendices are presented in the appendices, "A set of operating instructions for well repair", Guideline, patent documents issued for inventions, a conference certificate and textbooks.

The results of the thesis were published in these scientific works:

1. Ibrahimov Y.A. The method of removing deformed pipe ends in accidental production wells with a specially designed combined box-cutter. "Azerbaijan Oil Industry", 2011, No. 3, p. 21-25.
2. Ибрагимов Ю.А. Усовершенствованный способ цементирования с применением специальных растворов в скважинах с сильным поглощением жидкости. «Строительство нефтянных и газовых скважин на суше и море» 2016, № 1, p. 39-43.
3. Salavatov T.Sh., Ibrahimov Y.A. Improvement of the holding tools used in the overhaul of wells according to well conditions. "Azerbaijan Oil Industry", 2016, No. 6, p. 26-32.
4. Салаватов Т.Ш., Ибрагимов Ю.А. Определение силовых параметров при ловильных работах в добывающих скважинах. «Строительство нефтянных и газовых скважин на суше и море» 2016, № 6, p. 41-47.
5. Salavatov T.Sh., Ibrahimov Y.A. Comparative analysis of API standard and double butt joint drill pipes. "Azerbaijan Oil Industry", 2021, No. 6-7, p. 28-38.
6. Ибрагимов Ю.А. Эксцентричный забойный фрезер. «Строительство нефтянных и газовых скважин на суше и море» 2022, № 3, p. 15-18.
7. Ибрагимов Ю.А. Ведение аварийных работ в скважинах имеющих суженные зоны в эксплуатационной колонне. SOCAR Proceedings Spesial Issue., 01.2022. (No. 1 (2022) 057-061) p. 5.
8. Zeynalov R.M., Ibrahimov Y.A., Kazimova N.A. Methods of elimination of absorption zones created in drilling operations by cutting a side barrel. "Azerbaijan Oil Industry", 2022, No. 8, pp. 15-21.
9. Ибрагимов Ю.А., Казимова Н.А. Ведение аварийных работ при капитальном ремонте скважин. «Строительство нефтянных и газовых скважин на суше и море» 2022, № 10, p.42-47.
10. Iskandarov D.A., Ibrahimov Y.A. Educational book "Overhaul of Oil and Gas Wells", Baku, "Mars Print" publishing house, 25.02.2015, 508 p.

11. Ibrahimov Y.A. "Discussion of holding tools" Baku, "Mars Print" publication, 25.01.2018., 50p.
12. Salavatov T.Sh.,Ibrahimov R.S., Iskandarov D.A., Ibrahimov Y.A. "Underground Repair of Oil and Gas Wells" textbook. Baku, "Azernashr" publishing house, 20.10.2018, p. 761.
13. Iskandarov D.A., Ibrahimov Y.A. "Technique and technology of oil and gas well repair" textbook. Baku, "NQETL" Institute centralized printing house, 20.04.2019, p.911.
14. Ibrahimov Y.A. "Techniques and technology of cementing in repair and isolation of oil and gas wells" educational book, Baku, "Mars Print" publishing house, 27.08.2019, 580 pages.
15. Salavatov T.Sh., Iskandarov D.A, Ibrahimov Y.A. Rehabilitation of Accidental Oil and Gas Wells" educational book. Baku, "Mars Print" publishing house, 11.11.2020, 795 pages.
16. Iskandarov D.A., Ibrahimov Y.A. The method of installing a cement bridge in fountain wells.Invention patent I 2013 0050, 2013 year.
17. Iskandarov D.A., Ibrahimov Y.A. Method of cementing wells under pressure. Invention patent I 2014 0019, 2014 year.
18. Iskandarov D.A., Ibrahimov Y.A. Device for removing corroded lift pipes from the well. Invention patent I 2014 0020, 2014 year.
19. Iskandarov D.A., Ibrahimov Y.A. Device for removing sand-clogged lift pipes from the well. Invention patent I 2014 0077, 2014 year.
20. Ibrahimov Y.A., Akhundov F.A. Device for removing the broken pipe from the well. Invention patent F 2015 0006, 2015 year.
21. Ibrahimov Y.A. Device for removing small diameter elevator pipes from the well. Invention patent F 2020 0029, 2020 year.
22. Iskandarov D.A.,Abbasov S.A.,Mammadov A.A., Ibrahimov Y.A. Device for removing emergency protective pipes from the well. Invention patent I 2020 0050, 2020 year.
23. Искандеров Д.Э., Ибрагимов Ю.А. Эксцентричный плоскодонный забойный фрезер. Invention № 038472, Евразийское патентное ведомство (ЕАПВ). 2021 year.
24. Iskanderov D.A., Ibrahimov Y.A. Eccentric flat bottom hole cutter. Invention patent F 2022 0001, 2022 year.

25. Ibrahimov Y.A. A set of special instructions for repairing wells (11 Operating Instructions). SOCAR, "Azneft" Production Union. 2018.
26. Ibrahimov Y.A. Development of new accident tools, theoretical justification and method of summarizing the results in order to improve the quality of repair operations in accident exploitation wells. Guidance document. "Azneftkimyamash-Balakhani Machine-Building Plant" OJSC, "Azneft" Production Union. 2020.
27. Салаватов Т.Ш., Ибрагимов Ю.А., Аббасова С.В. Техника и технология, применяемые при установке цементных мостов. Материалы международного семинара «Рассхинские чтения». 4-5 февраль, 2016. Часть 2.Ухта, УГТУ, 2016. p. 83-89.
28. Ибрагимов Ю.А. Особенности ловильных работ при капитальном ремонте аварийных нефтяных и газовых скважинах. Материалы VI международной научно-практического конференции «Булатовские чтения», Краснодар., 2022. p. 224-229.
29. Зейналов Р.М., Ибрагимов Ю.А. Эксцентричный забойный фрезер. Сборник трудов III международной научно-практического конференции «Инновационные технологии в нефтегазовой отрасли», «Северо-Кавказский федеральный университет», Ставрополь, 2022. p. 258-262.

Personal service of the author in works performed with co-authors

[1, 2, 6, 7, 11, 14, 20, 21, 25, 26, 28] Completed independently;
[3, 4, 5, 8, 9, 27, 29] Problem setting, analysis and compilation of mining and theoretical data;
[10, 12, 13, 15] Collection of practical and theoretical data, analysis, research, preparation of the book
[16, 17, 18, 19, 22, 23, 24] Practical and theoretical data collection, analysis, research, drafting, preparation and application of invention documents.

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